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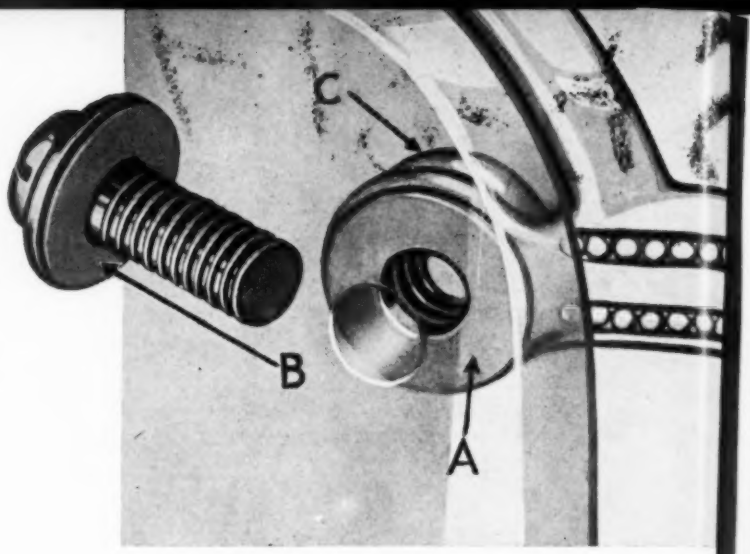

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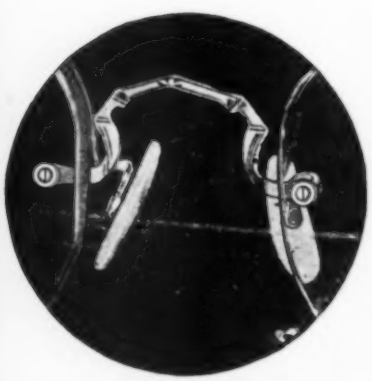

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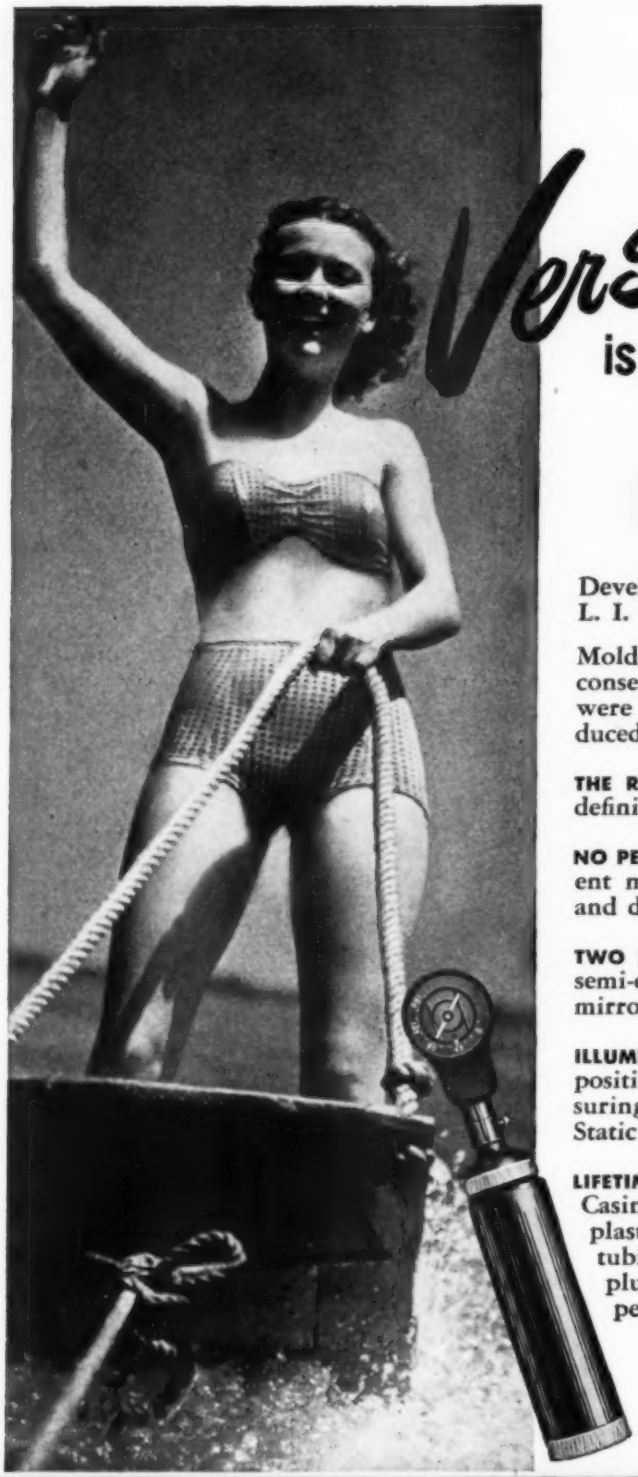

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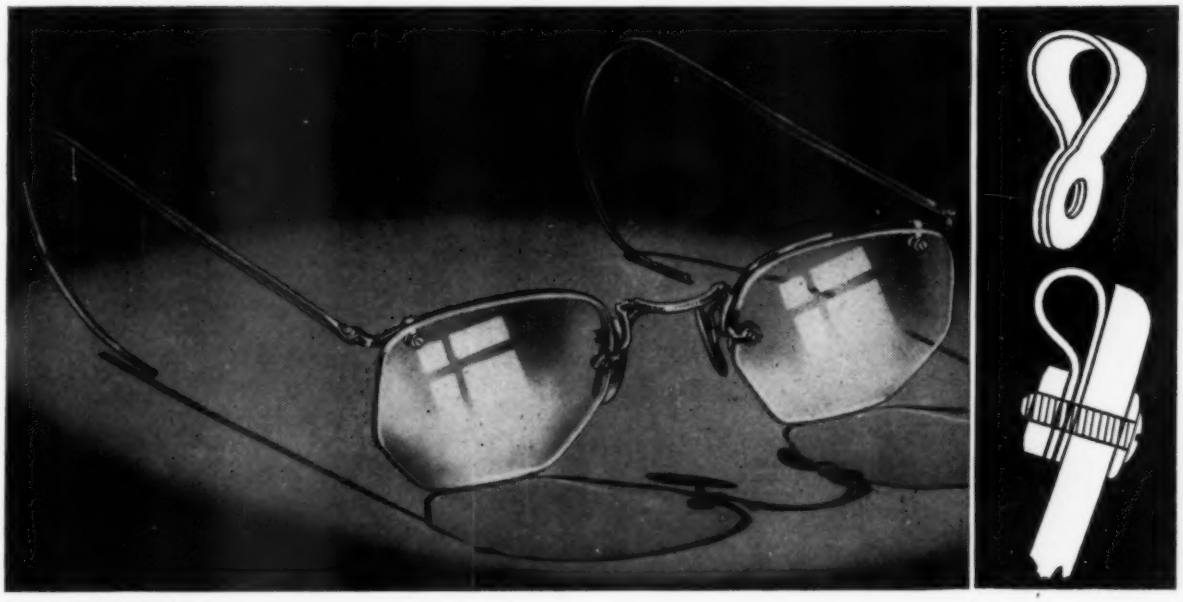

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AMERICAN JOURNAL OF OPTOMETRY
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Vol. 22 OCTOBER, 1945 No. 10

THE RELATION OF PUPIL SIZE TO ACCOMMODATION AND CONVERGENCE*

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School of Optometry
Ohio State University

1. INTRODUCTION

Weber's[1] investigation in 1851 of the pupil contraction associated with accommodation and convergence on a near object led to the conclusion that the pupil neither dilates nor contracts without a change of convergence. This was based upon results obtained with seeing accurately the same object alternately with plus and minus lenses. Cramer[2] and later Donders[3] repeated these experiments and found that tension of accommodation without change of convergence is attended by contraction of the pupil. Donders also reported that he was able to increase his accommodation voluntarily while holding his convergence fixed on a distance object and thus induce a contraction of the pupil. Donders reported further, however, that it is possible to demonstrate a change in pupil size by using prisms to converge the eyes without changing accommodation.

LeConte[4] made use of a checkerboard pattern to investigate changes in pupil size induced by changing convergence. He could converge his eyes at various points in front of the pattern and still obtain fusion of the overlapping parts of the right and left eye images. He noted that the pattern was out of focus for a moment after converging on a near point, but eventually cleared up. Also an assistant noted objectively that the pupils contracted but then returned to their original size as soon as the images cleared up. He concluded that the near response of the pupil is invariably associated with a change in focus.

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*An abridgment of the material presented at the annual meeting of the American Academy of Optometry at Chicago, Ill., December 12, 1944. For publication in the October, 1945, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

Other investigations of this type (the original reports of which have not been examined by the writer) are referred to by Duke-Elder;[5] namely, Borthern in 1892, Guillery in 1892, Seggel in 1895, and Moderow in 1905. Duke-Elder summarizes the data by saying that the pupillary reaction may occur with either accommodation or convergence with the other excluded but of the two is more nearly associated with convergence.

Donders' use of prisms to induce changes in convergence without affecting accommodation is open to the objection that it is practically impossible, as shown by recent studies,[6 7 8 9 10] to change convergence with prisms without introducing slight changes in accommodation, and the question might be raised whether the quantitatively measured changes in pupil size can be attributed to the associated changes in accommodation.

Furthermore, the analysis of convergence into accommodative and fusional components,[11 12] and perhaps also a psychic component,[13 14] does not seem to have been considered in previous investigations of the subject. From the point of view of this analysis it becomes a problem not of whether accommodation or convergence is the cause of pupil contraction but rather it is a choice between fusional convergence on the one hand and the combination of accommodation and accommodative convergence on the other. It is from this approach that the present investigation has been organized.

Furthermore, one must keep in mind a direct influence of the awareness of nearness on the size of the pupil, which might be related to the similar effects on accommodation and convergence. The influence of this factor can be systematically investigated as has been done in connection with psychic accommodation and convergence, but this has not been undertaken in connection with this report.

II. APPARATUS

The method employed in the present investigation involves the use of a haploscope in conjunction with targets for inducing changes in accommodation and convergence and a special device which could be used to measure either pupil-size or changes in accommodation.

The optical system is illustrated in Fig. 1A. The parts A through K were all mounted on the left arm of the haploscope which rotated around a vertical axis through the center of rotation of the left eye (L), and the parts E′ through K′ were mounted on the right arm which rotated around a vertical axis through L′. Each of the targets G and G′

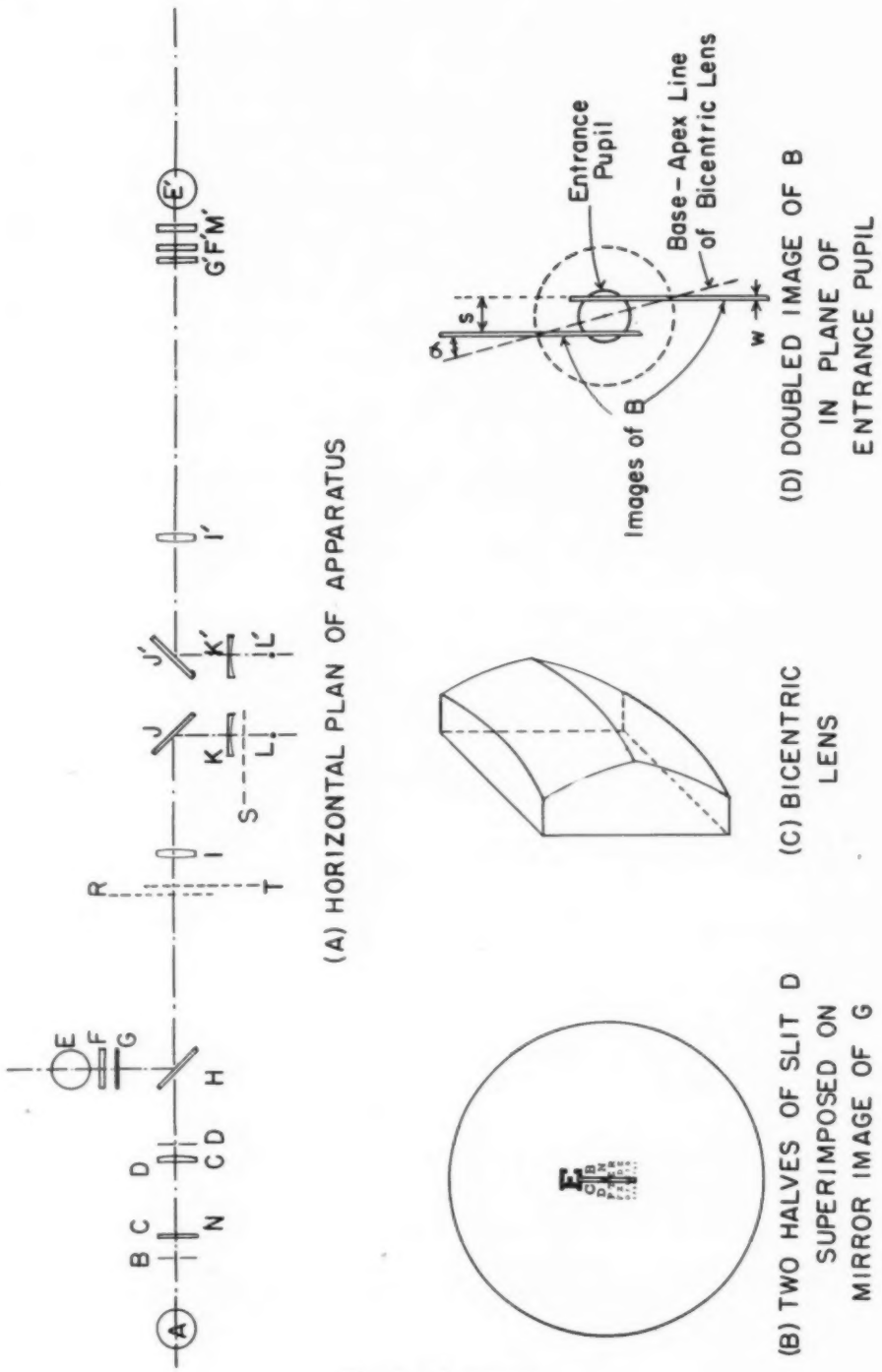

Fig. 1—Apparatus

consisted of a Snellen chart reduced to 1/40 normal size as shown in Fig. 1B. The target on each side was 32 mm. in diameter and its images formed by lenses I and K (or I′ and K′) subtended a visual angle of 12 at the center of the entrance pupil which was approximately 10 mm. in front of the center of rotation. The two lenses I and K (and also I′ and K′) constituted a telecentric system for this point (i.e., the secondary focus coincided with this point) and hence the targets underwent no change in angular size as they were moved in a fore and aft direction. The natural pupil of the eye constituted the aperture stop for this system. The refracting system consisting of I and K had a focal length of 154 mm. R and T represent the primray and secondary principal planes.

Since the light from G was only partially reflected at H, it was necessary to use a bulb with a higher candle power at E than at E′ and a filter M′ was also employed to help equalize the brightnesses of the two targets. In spite of all this the brightness of G (2.65 c/m^2 as seen through the eyepiece) was still not quite equal to that of G′ (2.95 c/m^2).

The target G and parts E, F, H, D, C, B, N and A were all mounted on a large sliding carriage which moved in a fore and aft direction; the target G′ and the parts F′, M′ and E′ were also mounted on a similar large carriage; the two large carriages were geared together and could be motor driven in either a fore or aft direction at a constant rate of 3.5 cm. per minute, which amounts to approximately 1.50 D. per minute in the range in which most of the measurements were made.

The two targets (G and G′) maintained the same distance from the lenses (I and I′) and hence the stimulus to accomodation was always the same for the two eyes. The stimulus to accommodation was given by the following formula:

$$\text{Stim. to Acc.} = \frac{1}{d - \dfrac{1}{\dfrac{1}{u} + F}} \qquad (1)$$

in which F is the refracting power of the system consisting of I and K, and is equal to + 6.50 D., and u represents the distance from R to G (a negative quantity) and d is the distance from T to S and is equal to 137 mm. S represents the spectacle plane 27 mm. in front of the center of rotation.

The two arms of the haploscope were also geared together to provide symmetrical convergence at all times, and could be motor driven in either direction by a constant speed motor. The mechanism controlling the convergence of the arms is such that, if 8 represents the tota amount of convergence constant, the relation between the rate of change in convergence of the two arms, Tan (½ 8 — 1.2°) undergoes a constant rate of change, namely .145 per min. As (½ 8 — 1.2°) approaches zero, the rate of change in convergence becomes constant at 16.4° per min.

The haploscope arms and the carriages were drvien by the same constant speed motor, but the manipulations of the a stimuli to accommodation and convergence were completely independent and were controlled mechanically by levers and reversing clutches.

The parts A, B, N, C and D constituted the device for measuring pupil size and accommodation. These were mounted on a small sliding support which was mounted on the large sliding support carrying also H, G, F and E. This small sliding carriage on the large sliding carriage made it possible to move the unit consisting of A, B, N, C and D in a fore and aft direction and to set D at a different distance from I than G. This movement was induced by the subject who turned a knurled knob controlling a pinion which drove a rack fastened to the small sliding carriage.

D was a diaphram containing a narrow vertical slit. C was a bicentric lens (see Fig. 1C), which had a plane back surface and a front surface composed of two intersecting spherical surfaces which gave the effect of a + 10.00 D. spherical lens combined with a 4.5△ biprism. B is a vertical slit illuminated by the source (A), and N is a red filter (corning 348, 3.5 mm. thick). The lenses C, I and K formed a double image of the vertical slit (B) in the plane of the entrance pupil of the eye which could be observed directly by placing a piece of ground glass in this plane and the observing eye at a point some distance back of L. Each image of the slit B thus formed was measured to have a width of about 0.2 mm. Since the slit (B) fell in the primary focal plane of the bicentric lens C, the size and the separation of the images of B in the pupillary planes were not affected by moving either the large or the small sliding carriage in a fore and aft direction. The presence of the two images in the pupillary plane indicated that the light from the upper and lower halves of the slit D entered the eye in the form of two laterally separated beams. In order for the two halves of slit D to be seen vertically aligned, the eye had to be accommodated for objects lying

in the plane of D (i.e., for red light, for the horizontal meridian and for a narrow zone of the pupil whose diameter was equal to the separa-

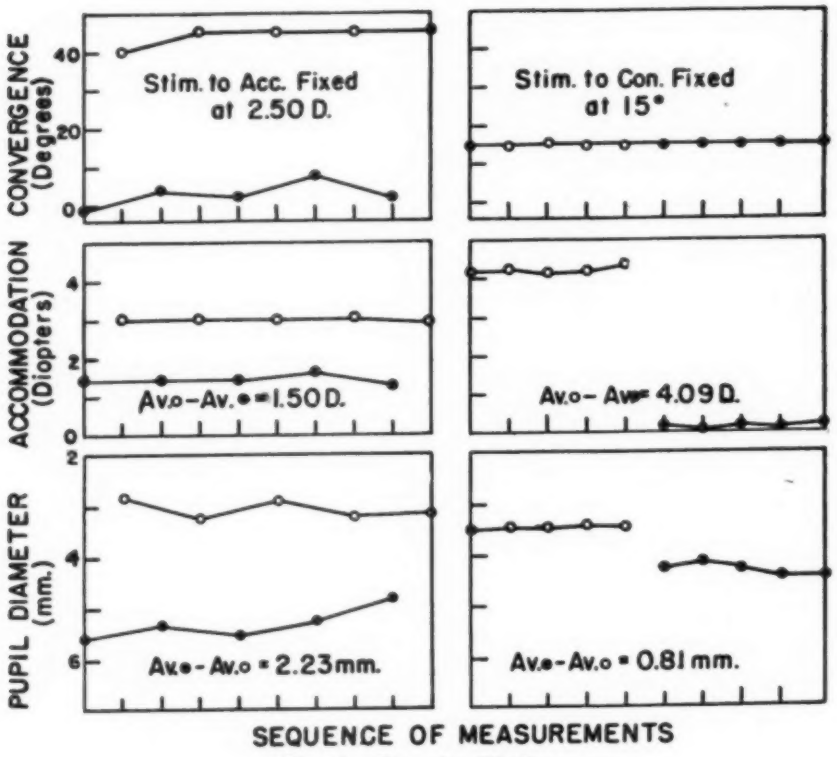

Fig. 2—Data for W. B.

tion of the two images). For the purpose of measuring accommodation, the separation of the images was kept constant at 2.5 mm. (i.e., from center to center). To measure the amount of accommodation in play, for a given stimulus to accommodation and convergence, it sufficed to move the small carriage to a point at which the upper and lower halves of D were seen aligned, and the accommodation was read from a scale. The quantity read corresponds to that defined by Equation 2 when u is defined as the distance from R to D instead of from R to G. The two halves of (D) were seen superimposed on the mirror image of the target (G). (See Fig. 1B.) In measuring accommodation the subject was required to try to focus on the letters while aligning the two halves of the slit (D).

No special pains were taken to get the two images of B symmetrically placed with respect to the pupil when making measurements of accommodation. The head was supported by means of a chin and a

forehead rest, but these permitted the subject to move his head laterally a slight amount and he was instructed to move his head laterally until both halves of the slit (D) appeared clear before making a measurement of accommodation.

As shown in Fig. 1D, the lateral separation of the two images of B in the plane of the pupil could be controlled by rotating the bicentric lens (C) around its axis. If alpha represents the declination of the base-apex line of the bicentric lens from the vertical, the lateral separation (s) of the images (center to center) is given by the following formula,

$$s = .02 \text{ f sin x } (\triangle)$$

in which f represents the focal length (154 mm.) of the refracting system consisting of I and K, and $\triangle$ represents the prism power in prism diopters ($4.50\triangle$) in each half of the bicentric lens.

The subject was permitted to rotate the bicentric lens by turning a knob and thus measure the size of his own pupil or he could let the operator turn the knob for him. In the earlier experiments, the subject manipulated the knob but in the latter part of the work the operator performed this function, because the setting proved to be obtained more quickly, and the subject felt freer to concentrate on the judgments that had to be made. In either case the basic procedure was the same.

The separation was arbitrarily reduced till he observer could see both halves of the slit (D) clearly. He then concentrated on focusing for the letters on the targets G and G′, and, as the separation increased, he reported at the moment at which either one or both halves of the slit disappeared. A period in which the slit grew faint preceded the final disappearance. If one of the slits disappeared before the other, this signified that the slits were not symmetrically placed with respect to the pupil, and the head was shifted laterally to bring both halves of the slit back into view, the separation was again increased until the subject made another report, and if necessary another lateral shift of the head was made and the separation was again increased until finally both halves disappeared at the same time, and the slightest movement of the head in either direction would bring one of them into view and an oscillation of the head would give an up and down stroboscopic movement, one-half of the slit disappearing as the other would come into view. When this result is obtained the pupil just spans the gap between the two lenses and its width is equal to the center to center separation (s) minus the width (w). The quantity 8 was read from a scale on the instrument and a calibration curve was used to obtain values of pupil width (s-w).

This method of measuring pupil width was not free from faults. In the first place most of the subjects had difficulty in keeping focussed on the letters and observing the slits at the same time. The measurements of pupil size and accommodation for a given stimulus to accommodation and convergence were not made concurrently and the only assurance that the same amount of accommodation was present in the two measurements was that the subject was instructed in each case to make the utmost effort to keep the letters focused. After a fashion the two measurements could have been made simultaneously by reducing the separation until both halves of the slit (D) could just be seen and then measuring accommodation, but this would demand of the patient that he wiggle his head, turn two knobs and make three types of judgments at the same time. Furthermore, because of spherical aberration the accommodation varies for different zones of the cornea and lens, and if the beams were kept touching the margins of the pupil, different zones would be employed for accommodation measurements with different pupil sizes. This source of trouble could be eliminated by making use of infrared photography to record the pupil size at the same time the accommodation measurement is made.

A second basic source of error arises in connection with the changes in retinal illumination which occur as a result of pupil contraction or dilation induced by changing the stimulus to accommodation or convergence. The reaction of the pupil to these changes in illumination partially cancels the effect induced by changes in accommodation or convergence.

III. PROCEDURE

The experiment was carried out in a dark room. The light source shown in Fig. 1A were completely enclosed except as used for illuminating the slits and targets. The only additional light was a small 7½ lamp which was turned on and off for the purpose of reading the settings but was not exposed directly to the subject.

Because of the difficulties encountered by the subjects in making the measurements it was decided to limit the measurements to a relatively small number of different conditions. In the first part of the experiment, determinations of accommodation and pupil size were made with a fixed stimulus to accommodation (2.50 D.) and with the maximum and minimum stimuli to convergence that permitted fusion. Clear vision at the limits of fusion was not considered essential, although the subjects were instructed to focus as accurately as possible. For the first reading the targets were motor driven to the divergence limit of single vision

and then brought back to the point at which the subject had no difficulty maintaining single vision. The accommodation was the first measurement and then the pupil size and then both settings were recorded along with the convergence of the haploscope arms. The haploscope arms were then motor driven in the direction of convergence till diplopia was obtained and the arms were brought back to the point that single vision could be maintained. Accommodation and pupil size measurements were then made and recorded along with the convergence. This whole procedure was repeated five times.

Following this procedure an effort was made to investigate the effect of keeping convergence constant and changing accommodation. The amount of convergence chosen for this experiment represented an intermediate point between the two limits of convergence with a 2.50 D. stimulus to accommodation which was regarded as likely to give a good range of relative accommodation. In controlling accommodation, either of two procedures was followed. In some instances the average values of accommodation at the two limits of convergence were determined from the readings obtained with the procedure described above. With the subject fixing the targets and continuously adjusting the knob to keep his accommodation measured, the targets were motor driven in the direction of increasing the stimulus to accommodation to the point at which the measured accommodation reached the higher of the two average values, and then the pupil size was measured. After this the targets were motor driven in the opposite direction till the measured accommodation reached the lower of the two average values and the pupil size was again measured. This whole procedure was repeated five times.

In other cases the stimulus to accommodation was set at some value above 2.50 D. at which the subject felt certain that accommodation could be maintained with the fixed amount of convergence, and the accommodation and pupil measurements were made alternately until five of each were obtained.

The same procedure was followed with a fixed stimulus to accommodation less than 2.50 D.

The reason for alternating the readings at the two limits of accommodation and convergences is that the data show systematic drifts which are attributable either to slow changes in pupil size caused by uncontrolled factors or by changes in the criteria on the part of the subject as to what constitutes a proper setting. As long as the readings at the two limits are taken alternately, the drifts affect one reading about as much as the next, and the average readings can be compared with each other.

The subjects consisted of juniors and seniors in the School of Optometry who had no previous experience in making subjective measurements of pupil size, and who had only an elementary appreciation of the purpose of the experiment.

Although six subjects were tried out, two of them showed little aptitude in making the pupil size measurements which requires a certain amount of skill and were dismissed without letting them complete the experiment.

Each of the remaining subjects was given preliminary practice until it was certain that he had acquired the knack of making satisfactory measurements of accommodation and pupil size.

IV. RESULTS

For the purpose of demonstrating drifts in pupil size and analyzing their cause, the data for accommodation, convergence and pupil size have been plotted as functions of the order of readings as shown in Figs. 2, 3, 4 and 5.

In the case of J. M. (Fig. 3) there is indicated a gradual decrease in the size of the pupil throughout the series of measurements with dif-

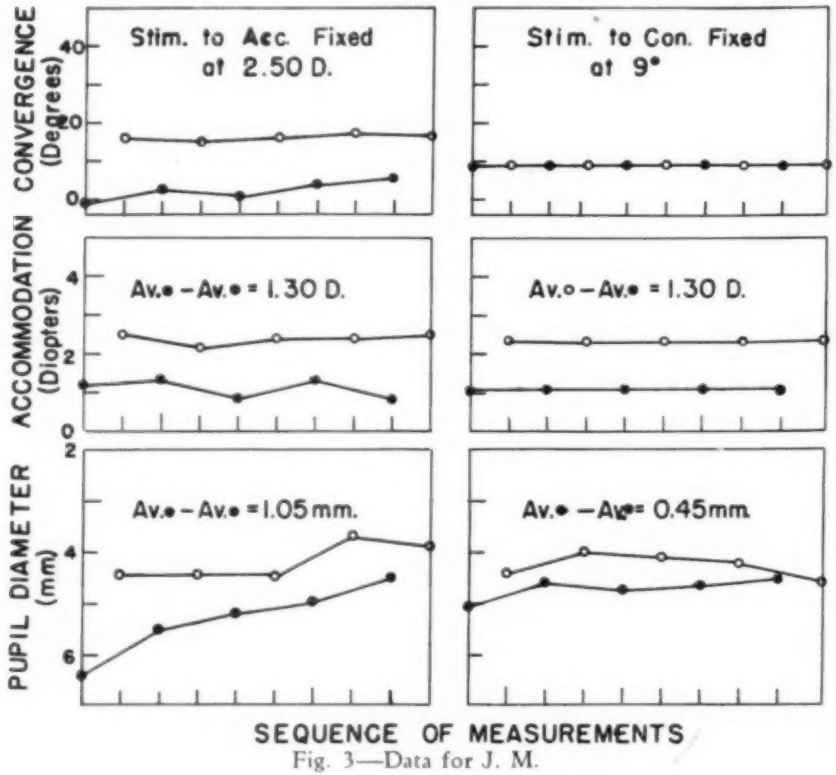

Fig. 3—Data for J. M.

ferent amounts of convergence. The base-in limit showed a similar drift, which is probably an after-effect of maintaining the eyes in a converged position with accommodation inhibited. The possibility that the two effects may be related is worth calling attention to.

In the case of B. R. (Fig. 4) drifts occurred which do not seem to be related in any way to accommodation and convergence.

In the first half of the experiment which involves changes in convergence, the results for subjects W. B. and J. M. (Figs. 2 and 3) indicate that the changes in convergence induce not only changes in pupil size, but also changes in accommodation. This indicates that the changes in pupil size associated with convergence are not necessarily associated with the changes in convergence per se but may be associated with the concomitant changes in accommodation.

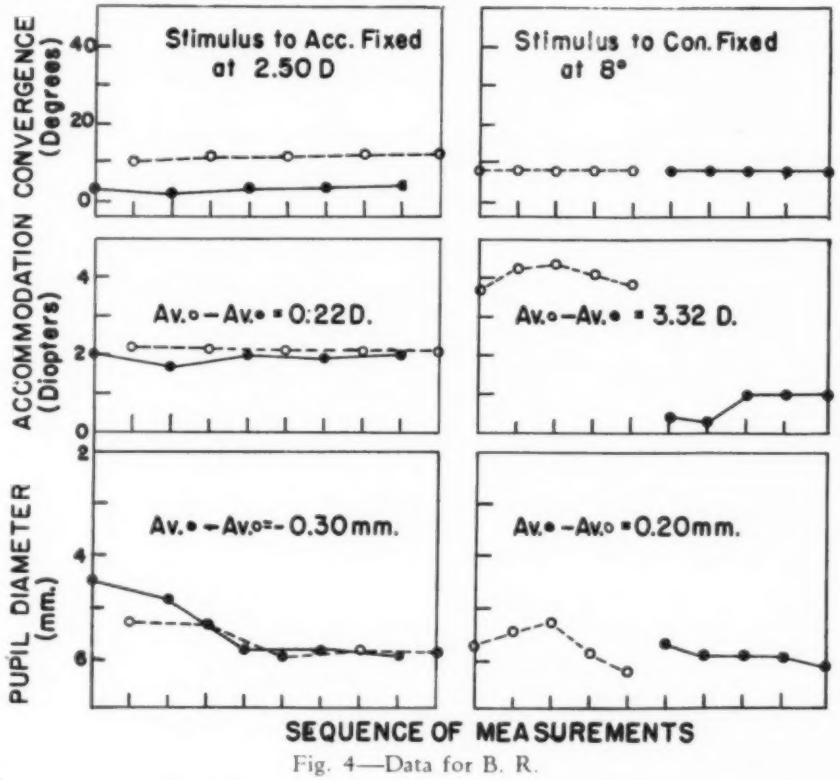
Stimulus to Acc. Fixed at 2.50 D
Stimulus to Con. Fixed at 8°
CONVERGENCE (Degrees)
ACCOMMODATION (Diopters)
PUPIL DIAMETER (mm.)
Av.o−Av.• = 0.22 D.
Av.o−Av.• = 3.32 D.
Av.• −Av.o = −0.30 mm.
Av.• −Av.o = 0.20 mm.
SEQUENCE OF MEASUREMENTS

Fig. 4—Data for B. R.

The results obtained in the second part of the experiment are plotted in the right hand graphs of Figs. 2 and 3. These graphs indicate that changes in pupil size can be induced by changing accommodation without changing the triangulation of the lines of sight.

A casual inspection of the graphs indicates that the changes in pupil size induced by accommodation alone is not as great as when accommodation is accompanied by changes in convergence.

The problem was quantitatively evaluated by calculating the average changes in accommodation and pupil size induced by changing convergence along with accommodation and by changing accommodation alone, and by dividing the average change in pupil size by the average change in accommodation to determine the number of mm. decrease in the size of the pupil for each diopter of increase in accommodation. The data for W. B. and J. M. are summarized with the following results.

The data thus summarized show a much greater effect in pupil size when both accommodation and convergence are changed, than when accommodation alone is changed.

Before attaching too much significance to this fact one must consider the following facts. The accommodation and pupil measurements were not made simultaneously. At the upper limit of convergence for a given stimulus to accommodation, the subject had to hold accommodation in check but at the upper limit of accommodation for a given stimulus to convergence he had to force it into play, and during the pupil measurement when he had difficulty keeping his eyes focused on the letters, the accommodation was apt to slip in one direction for one set of measurements and in the opposite direction for the other set. The situation is just reversed at the lower limits of convergence and accommodation.

It is not at all inconceivable, therefore, that if the pupil size had been measured simultaneously with accommodation by objective observation or infrared photography, the results would have shown the change in pupil size induced by convergence is just as definitely associated with accommodation as the changes induced by changing the stimulus to accommodation when triangulation is fixed.

It is obvious that the easiest way to find a definite answer to this question is to resort to a method which provides stimultaneous measures of accommodation and pupil size, and plans have been made for carrying out such an investigation.

The data for subject B. R. are presented in Fig. 4. In this case there are no appreciable changes in accommodation or pupil size with change in convergence. This indicates, offhand, that the changes in convergence can occur without change in pupil size. However, when an attempt was made to induce changes in accommodation with convergence fixed, significant changes in pupil size failed to show up under these

circumstances. Since the pupil definitely contracts when this subject has one eye occluded and focuses on a near object which requires about 5.00 D. accommodation, it is possible that in the experiment with fixed convergence the subject simply failed to keep focused on the target while making the pupil size measurements. The need for simultaneous measurements of pupil size and accommodation is definitely indicated.

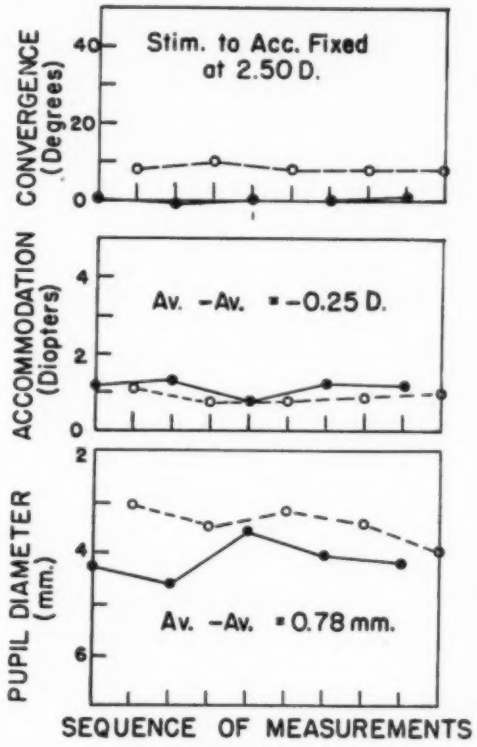

Fig. 5—Data for J. S.

The data for subject J. S. are presented in Fig. 5. This subject was the only one who showed significant changes in pupil size in response in changes in convergence, which were not accompanied by changes in accommodation. In the case of this subject, it was not possible by the method used to determine to what extent changes in pupil size could be be induced by changes in accommodation while convergence remained fixed, because he was completely frustrated with the problem of maintaining a focus for the letters while at the same time watching the slit to measure pupil size.

By the ordinary push-up method the subject manifested over 5.00 D. accommodation, and the results cannot be explained as might be the

case in aphakia or presbyopia on the ground that contraction of the ciliary muscle occurs without changes in accommodation.

It will be important to reinvestigate this subject's responses when a method is devised for measuring accommodation and pupil size simultaneously, because if the same results can be obtained under such conditions, unquestionable evidence would be provided that, in one case, at least, pupil size can be associated with fusional convergence which is not related to changes in accommodation.

V. DISCUSSION AND SUMMARY

When changes in accommodation occur with triangulation fixed, it must be recognized that changes in the innervation to convergence may be occurring at the same time. According to Maddox' analysis of convergence into accommodative and fusional components, the changes in accommodation which occur when triangulation is fixed, must be accompanied by changes in accommodative convergence which have to be compensated by changes in fusional convergence.

According to this analysis, the fact that changes in pupil size occur when accommodation changes with triangulation fixed, demonstrates that pupil contraction, accommodation and accommodative convergence are all associated together and the remaining problem concerns whether fusional convergence can also induce a change in pupil size. The only clear evidence of this found in the present study occurs in the case of one subject whose data indicate that changes in pupil size occur with changes in convergence which are not accompanied by changes in accommodation.

In the remainder of the cases, the changes in pupil size can most likely be attributed to changes in accommodation and the associated accommodative convergence. It is useless to speculate further on the physiological and psychological significance of the data, until the experiments are repeated with provision for simultaneous measurements of pupil size and accommodation.

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RADIANT ENERGY FROM FLUORESCENT LAMPS*

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The advent of a new source of artificial light commonly results in various suspicions and complaints. This is sometimes true in a lesser degree when a radical change in a lighting installation is made. Anyone who has witnessed various major advances in light production and in systems of lighting, and who has been in a position to receive inquiries and complaints, knows that many suspicions are entirely unwarranted from either a factual or a theoretrical basis. Some appear to spring from a confusion of glare with a meager acquaintance with the known facts of radiant energy. Confusion of this sort can only be dissipated by quantitative measurements or experienced observation and analysis. Complaints of fluorescent lighting which have any factual basis are generally found to be due to glare from bare lamps in the visual field or to other violations of the principles of good lighting and seeing conditions. Those which involve indictments of the radiant energy emitted by fluorescent lamps find no support in knowledge and experience or even in sound theory.

Many in the lighting industry recall the suspicions which arose when the mercury lamp—the Cooper-Hewitt mercury arc—was introduced for lighting purposes. It was accused of emitting ultraviolet energy in quantities harmful to the eyes and even to the skin. Its discontinuous spectrum was accused, on the basis of vague unsupported theory, of being detrimental to the visual sense. Similarly infrared energy emitted by filament lamps has been accused, and still is occasionally, of harmful biological effects, notwithstanding the fact that no such effects of infrared energy have been established. Furthermore, there is no sound theoretical basis for such a suspicion.

Even the meager and spectrally limited ultraviolet energy from tungsten-filament lamps was seriously suspected of being harmful. Bulbs of special glass and even "protective" eyeglasses were recommended in the early part of the tungsten filament era. When the blue-green bulb converted the tungsten-filament lamp into a so-called "daylight" lamp, a minor flood of suspicions and complaints arose. Many were ridiculous

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in varying degree, as is true in these early years of fluorescent lighting. Glare and poor seeing conditions, including inadequate light upon the task, have been the common causes of the justifiable complaints.

In appraising suspicions and complaints of light and lighting, it should be borne in mind that most persons who make the original complaints can scarcely qualify as competent observers or analysts. Furthermore, there is no more fruitful field for quacks and quackery than in the field of light, color and radiant energy. Note the extensive use of so-called color-therapy notwithstanding the lack of a sound foundation of acceptable proof. Lighting is not entirely free from this kind of practice "beyond knowledge" which, whether intentional or not, is quackery. Of course, a certain illuminant may possess specific advantages in specific cases involving the appearance of color, esthetic or psychological effects, and the mixture of artificial light with natural daylight.[1] However, common illuminants do not differ significantly in their contribution to visibility. Even the differences in effectiveness in this respect among colored illuminants are surprisingly slight as measured by various criteria which have been adequately developed by careful and extensive research. Purely monochromatic light is an exception under certain conditions, but obviously this as well as the other "colored" illuminants is not acceptable for general lighting practice.[1]

ULTRAVIOLET ENERGY

No reputable manufacturer would make a light-source available to the public without adequate control of the output of ultraviolet energy. Nevertheless, fluorescent lamps have been extensively subjected to suspicion in this respect and some eyesight specialists and others have advocated tinted eyeglasses or safety glasses to "protect" the eyes from the ultraviolet energy emitted by these lamps. It should be realized that the composition of the glass envelope of a light-source can be so controlled that the short-wave limit of the spectrum of the transmitted energy can be fixed at any point desired. For example, the manufacturer may decide to limit the spectrum of a light-source to that of natural sunlight or skylight. It should also be realized that the harmful effect of ultraviolet energy not only depends upon the wavelength of the energy but also upon the intensity of the energy upon the eyes, skin, etc. In addition *time* is a factor. In other words, the harmful dosage of energy of a given wavelength is a matter of *time* times *intensity*. Without quan-

[1] *Light, Vision and Seeing* by Matthew Luckiesh, D. Van Nostrand Co., New York, 1944.

titative measurements of these factors in terms of the biological effect under consideration any conclusion is purely speculative.

The spectrum of natural sunlight or skylight ends in the ultraviolet region in the neighborhood of λ2950. At high altitudes it may extend slightly further but it seldom if ever reaches λ2900 anywhere that human beings are exposed in large numbers for long periods. Careful studies of the erythemal effect of ultraviolet energy have been made for normal eyes and skin. The effectiveness of energy of wavelengths longer than λ3150 in producing erythema of the skin or conjunctivitis (inflammation of the conjunctiva or outer membrane of the eye) is negligible excepting in dosages never encountered with fluorescent lamps indoors and rarely encountered outdoors.

TABLE I—INTENSITY OF ULTRAVIOLET ENERGY SHORTER THAN λ3150 MEASURED IN MICROWATTS PER SQ CM FOR CERTAIN LEVELS OF ILLUMINATION DURING THE MIDDAY HOURS ON CLEAR DAYS IN SUMMER, COMPARED WITH THAT FROM WHITE (3500°) FLUORESCENT LAMPS.

a. Direct sunlight
b. Skylight, clear blue sky
c. Sunlight plus skylight
d. Direct fluorescent light, 3500° white

	Footcandles	Microwatts per sq cm		Microwatts per sq cm per footcandle	
		Actual	Relative	Actual	Relative
Intensity of ultraviolet energy shorter than λ3150*					
a.	6600	56	70	0.0085	0.53
b.	1900	117	146	0.0620	3.85
c.	8500	173	216	0.0205	1.28
d.	50	0.8	1	0.0160	1.00
Intensity of ultraviolet energy shorter than λ3150 erythemally weighted**					
a.	6600	7.5	214	0.00114	1.63
b.	1900	15.6	450	0.00820	11.7
c.	8500	23.1	660	0.00272	3.88
d.	50	0.035	1	0.0007	1.00

*Most surfaces do not efficiently reflect ultraviolet energy shorter than λ3150. Therefore, the footcandles due to reflected light are generally accompanied by relatively little of this erythemally effective energy.

**A six-year record of erythemally weighted ultraviolet energy in daylight indicates that in midwinter it is about 0.1 that in midsummer at 40° N latitude.

In a laboratory equipped for such work delicate measurements of ultraviolet energy in various prescribed and meaningful ways are readily made. For many years ultraviolet energy has been a major interest of the authors and their colleagues. Although the intensity of ultraviolet energy (shorter than λ3150) from sunlight and skylight outdoors varies considerably even on clear days, typical results obtained during midday in midsummer are presented in Table I. This band of ultraviolet energy is measured in micro-watts per square centimeter for the levels of illumination indicated for the various illuminants. It is seen that the intensity of this erythemally effective energy is commonly a hundred times greater on a clear day outdoors during the midday hours in midsummer than it is for 50 footcandles of direct or unreflected light from white (3500°) fluorescent lamps. The ultraviolet energy shorter than λ3150 emitted by daylight (6500°) fluorescent lamps is about 2.3 times that from white fluorescent lamps. The actual output of this ultraviolet energy from fluorescent lamps varies with the thickness of the glass, with the coating of the phosphors and other factors but the variations are insignificant for the present purpose.

In the lower part of Table I the values of ultraviolet energy shorter than λ3150 are erythemally weighted. Thus they represent a better picture of the effects upon the skin and the conjunctiva. The values in the third column indicate that sunlight and skylight on a clear day during the midday hours in midsummer are commonly several hundred times as erythemally effective as 50 footcandles of direct light from white fluorescent lamps.

In the last column of Table I are presented the actual and relative values of ultraviolet energy shorter than λ3150 *per footcandle*. When the footcandle intensities of sunlight, skylight and fluorescent light are multiplied by these factors it is seen that there is no cause to worry about the ultraviolet energy from levels of illumination from fluorescent lamps many times greater than those now being specified. In fact, workers in lamp factories exposed all day long to 600 footcandles of light directly from fluorescent lamps have suffered no effects attributable to ultraviolet energy. Actually the intensity of erythemally weighted ultraviolet energy upon their eyes is much less than the intensity their eyes are exposed to outdoors during midday on a clear day in midsummer. In this connection it should be emphasized that the biologically-effective ultraviolet energy is generally greatly reduced by reflection from most surfaces.

The intensity of erythemally weighted ultraviolet energy on the earth's surface due to skylight is often greater than that due to direct

sunlight during midday.[2] This is indicated in Table I but an example is helpful.

If a person is standing outdoors on a clear day during the midday hours in summer with his back to the sun, the level of illumination at the vertical plane of his eye may be 500 footcandles due to light from a clear blue sky. The ultraviolet energy shorter than λ3150 per footcandle of direct skylight is 3.85 times greater than that accompanying one footcandle of direct light from white fluorescent lamps. Therefore, from this viewpoint the 500 footcandles of direct light from the sky are accompanied by as much of this ultraviolet energy as 1925 footcandles of direct light from white fluorescent lamps or about 840 footcandles of direct light from daylight fluorescent lamps.

Considering, in addition to this, the fact that most reflecting surfaces have low reflection factors for this ultraviolet energy shorter than λ3150, there is no factual basis for suspecting that fluorescent lighting can possibly be harmful to normal eyes and skin. Obviously this statement is a safe one for levels of illumination many times greater than those of the best fluorescent lighting practice of the present time. If the comparison with skylight is made on the basis of erythemally weighted ultraviolet energy, as indicated in the lower half of Table I, it is obvious that several thousand footcandles of fluorescent light would be no more "harmful" than 500 footcandles of light during midday on a clear midsummer day.

TABLE II—Intensity of Radiant Energy per Footcandle for Various Illuminants

	Microwatts per sq cm per footcandle	
	Actual	Relative
Clear skylight through ⅛-inch glass	4.9	0.61
Sunlight, midday midsummer	9	1.12
Sunlight through ⅛-inch glass	7.5	0.94
Fluorescent lamp, 40-w, 3500°	8	1.00
Same through ⅛-inch clear glass	3.5	0.44
Fluorescent lamp, 40-w, 6500°	10	1.25
Same through ⅛-inch clear glass	4.5	0.56
Tungsten-filament lamp, 60-w	55	6.9
Tungsten-filament lamp, 100-w	45	5.6
Tungsten-filament lamp, 200-w	40	5.0

[2]Seasonal Variations of Ultraviolet Energy in Daylight, Matthew Luckiesh, A. H. Taylor and G. P. Kerr, *Journal of the Franklin Institute*, 238, 1944, 1.

It is possible that the conjunctiva may lose some of its adaptation to ultraviolet energy just as skin does during the winter months when the sun is at low altitudes. However, it should become adapted again just as the skin does outdoors. There is also the possibility of an abnormality of the skin or of the eyes in some cases which might make a person supersensitive. However, such a person should experience real trouble if exposed to skylight outdoors even for a short period of time.

INFRARED ENERGY

Little space need be given to a discussion of infrared energy accompanying the light from fluorescent lamps. There is scanty evidence that this energy is directly responsible for any biological effect and certainly there is no proof that it is harmful to the eyes or skin in dosages obtainable under artificial lighting conditions. However, in respect to the quantity of infrared energy, light from fluorescent lamps compares favorably with that from midsummer sunlight and skylight.

It is seen in Table II that the total radiant energy accompanying one footcandle, supplied by light directly radiated from the bare light source, is about the same for fluorescent lamps as for midday midsummer sunlight. A sheet of clear glass ⅛ inch in thickness considerably reduces the total radiant energy per footcandle from these sources. Actually fluorescent light after passing through this additional sheet of glass is as "cool" as skylight entering through a glass window. Viewed quantitatively with proper consideration of footcandle levels, it is overwhelmingly obvious that infrared energy from fluorescent lamps is harmless to eyes if daylight outdoors is harmless. And certainly human eyes are adapted physically and physiologically to this and other aspects of the outdoor environment under which they evolved.

From Table II it is seen that the total energy accompanying a footcandle of tungsten-filament light is about five times the quantity accompanying fluorescent light or sunlight. In this respect 100 footcandles of direct tungsten-filament light equal about 500 footcandles of sunlight. The intensities of sunlight on the eyes and skin in the summertime are commonly 5000 footcandles.

VISIBLE RADIANT ENERGY

Certain vague ideas and loose theorizings in regard to the spectral character of light or visible radiant energy have persisted for a long time. In general they are important only as nuisances. With the advent of fluorescent lamps some of these have been revived and the "vitamin era" has added a new influence. Many who practice illuminating engineering

are confused and even left in doubt, for the reason that they do not have a sufficient background of knowledge in various sciences to understand or to appraise these speculations. This is particularly true when the speculations are expressed in the complex unfamiliar language of branches of science not extensively associated with light and lighting.

During many years of research with visible and invisible radiant energy one becomes familiar with, and active in, various highways of science extending far beyond physics into such realms as physiology, biology, psychology, and ophthalmology. From this extended experience one must conclude that there is no proof at present that the spectral distribution of energy of any illuminant, suitable for general lighting applications, is any more detrimental to the eyes or visual sense than that of any other illuminant suitable for extensive use. As yet the only source of suspicion is loose theorizing or mere speculation with no foundation of sound theory or measurement. Theorizing is a necessary step in temporarily bridging the known with the unknown. However, it should be properly labeled and it must not ignore known facts and experience. Theorizing without any basis of fact is nothing more than speculation. Even this has its place but it should be confined chiefly to the realms of scientists. Certainly it provides no foundation for any conclusion or practice.

First let us consider all illuminants that are acceptable rather generally for extensive use. Among these are the visible energy, regardless of the spectral distribution of energy, emitted by tungsten filaments, mercury arcs and fluorescent lamps. Obviously these differ widely in spectral character as indicated in Fig. 1. In each class they differ widely among themselves in this respect. Daylight must also be included and it is obvious that it varies enormously from deep blue skylight to direct or reflected sunlight from the sun at different altitudes. However, when these illuminants are applied to a visual task under the same seeing conditions, a given level of illumination from one illuminant has no significant advantage or disadvantage over that of any of the other illuminants as indicated by such criteria as visual acuity and visibility.

Criteria of eye fatigue and ease of seeing are not as well established as yet. However, even in these respects there is no generally acceptable proof that the foregoing illuminants differ significantly. If any significance is to be attached to results which indicate otherwise, the advantage is in favor of white light or average daylight, in comparison with the yellowish light from filament lamps.

Notwithstanding the foregoing, slightly tinted lamps have been

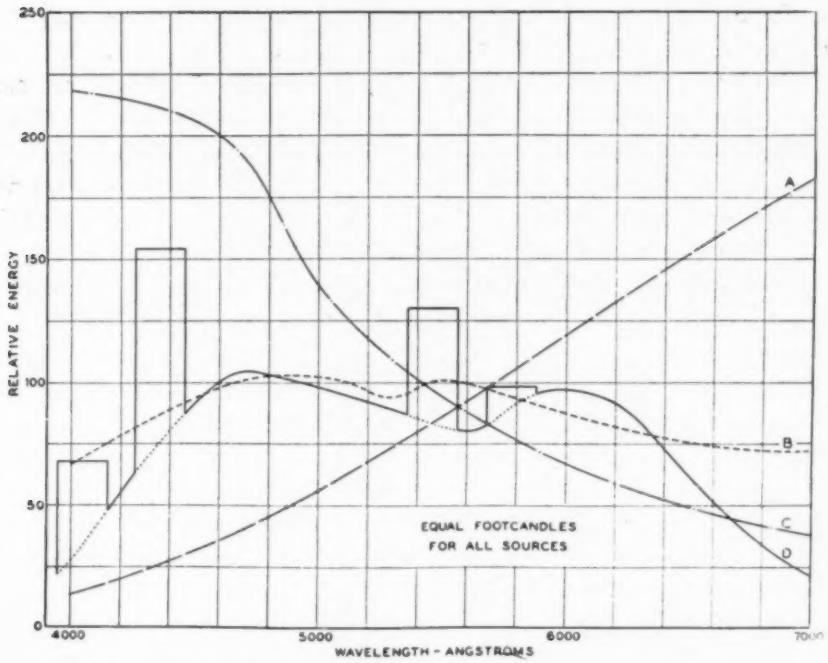

Fig. 1—Energy distribution in the visible spectrum for equal intensities of illumination.

A—Black body at 2850° K (approximate for 100-watt tungsten-filament lamp).
B—Natural daylight, sunlight plus clear sky, 6500° K.
C—Zenith sky, 60,000° K.
D—Daylight (6500° K) fluorescent lamp.

presented to the public with claims contrary to those of extensive research and with new claims added which have not been adequately proved, at least to the satisfaction of many familiar with the knowledge available and the complexities involved. This alone emphasizes the great need for knowing at least what is known. Certainly lighting specialists first of all should be able to distinguish among proved fact, sound theorizing and mere speculation. They should be able to recognize quackery and should help to combat it.

One of the perennial suspects among the various characteristics of common illuminants is the discontinuous spectrum as exhibited by the mercury arc of the older type. As is well known, its visible energy is confined almost entirely to four spectral lines in the regions indicated by the four rectangles projected above the continuous spectrum *D* in Fig. 1. Between these "lines" of the spectrum of the Cooper-Hewitt type of mercury arc there are gaps in which little or no energy is radiated. This

discontinuous spectrum has been much berated without an iota of proof upon which to base a suspicion.

If a white surface is illuminated by the light from this mercury arc with a discontinuous spectrum, the visual sense appraises the surface as a white with a greenish tint. The eye does not "know" whether this white surface is illuminated by an illuminant with a discontinuous or a continuous spectrum. Actually the visual sense is unable to determine the spectral characteristics of common illuminants plotted in Fig. 1. Incidentally, these distributions of energy are plotted for equal intensities of illumination; that is, for equal footcandles on a perfectly white surface.

Throughout the realm of physiological optics there is no fact which supports the suspicion that this discontinuous spectrum is "harmful" in any way. Speculators seem to lose sight of the fact that the visual sense synthesizes. Furthermore, uncounted thousands of persons have performed critical seeing for years under mercury-arc light with its discontinuous spectrum without any discovery of ill effects, by ophthalmologists or other qualified specialists, which have been proved to be due to spectral discontinuity.

The spectral characteristic of the visible energy from fluorescent lamps is a continuous spectrum upon which the discontinuous spectrum of mercury is superposed. As seen in *D* in Fig. 1 the spectrum of the visible energy emitted by the "daylight" fluorescent lamp is continuous but irregular on account of the mercury "lines." Certainly if no positive evidence of harmful effects of the discontinuity of the mercury spectrum exists there is no cause for suspecting the continuous though "irregular" spectrum of the light from the fluorescent lamps in common use. Furthermore, millions of persons have already performed critical seeing for long periods under fluorescent lighting without any positive evidence of harmful effects *due to the spectral character of the light*.

One common source of confusion in this respect is the failure to discriminate between glare due to brightnesses and brightness-contrasts in the visual field of the worker. Incidentally, it has not been established that light of one spectral character is any more or less glaring than light of another spectral character. On the contrary the evidence of some researches indicates that there is no difference in this respect among illuminants differing moderately in color. Certainly the illuminants commonly in use differ greatly in spectral character but only moderately in color. In fact, all are unsaturated tints rather than pronounced colors. Therefore, glare from common illuminants must be considered a matter

of brightness or quantity of light rather than a matter of the kind of light.

In a recent paper, and in discussions with him, Harmon[3] has revived some of the old speculations and has added a new one arising from the present vitamin era. Unfortunately in comparing tungsten-filament light with fluorescent light Dr. Harmon did not control glare. In his major investigation of lighting he dealt with a direct system of fluorescent lighting with bare lamps in the visual field of the workers and an indirect system of tungsten-filament lamps. From the viewpoint of harmful effects of glare, indirect lighting with filament lamps is obviously better than direct lighting with fluorescent lamps when many of the latter are visible in the visual field of the workers. These were the types of installations from which complaints arose which Dr. Harmon investigated. However, no conclusions in regard to the effect of spectral character of light upon the eyes are sound unless all other factors are controlled and the seeing conditions are identical with the exception of the spectral characteristics of the illuminants which are being compared.

Vitamins are among the great contributions of science in the present era. Appreciation of their beneficence is not altered by the extravagance of some claims and of some efforts toward their commercialization. A deficiency in riboflavin is apparently revealed by vascular signs around and within the edge of the cornea. The eyes are "blood-shot" in this region. Some excellent work has been done with this criterion, as, for example, on pilots flying over water in the daytime. The reflection of the sun's image from water is very glaring. Ariboflavinosis, or a deficiency of riboflavin, appears to be one of the results. Some believe that this is due directly to exposure to light. However, no systematic research has proved that it depends upon the spectral character of the visible energy, at least within the variations of spectral character among common illuminants. Here again glare due to brightness may be the sole culprit. We know that the effects of glare are far reaching. It not only causes eyestrain and eye fatigue, but also tenseness and annoyance. Therefore, the effects of glare pervade the physical, physiological and psychological realms of a human being.

In some speculations it is implied that if exposure to light causes a riboflavin deficiency this is a harmful or deleterious effect. One might just as well conclude that walking or working causes harmful effects through the "deficiencies" which result. We eat, drink, rest and sleep to make up deficits due to working—and living. Degeneration and re-

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[3]Lighting and the Eye, D. B. Harmon, *Illuminating Engineering*, 39, 1944, 481.

generation in uncounted processes are continually going on in the living human being. However, in the problem of exposure to light—if there is a problem—we should not lose sight of the need for adequate light and proper lighting. There is adequate proof that inadequate light and improper lighting and other aspects of poor seeing conditions adversely affect the human being and human resources. Medical, health and welfare authorities have lagged far behind in recognizing the possibilities of modern light-sources.

In Fig. V of his paper Dr. Harmon shows the absorption spectrum of riboflavin. It extends from the middle ultraviolet region through the violet, blue and blue-green portions of the visible spectrum. In other words, it indicates that riboflavin absorbs visible radiant energy shorter than $\lambda 5100$ to some degree. He then makes a not uncommon error in interpreting the meaning of the absorption spectrum. He assumes that, because violet, blue and blue-green light is absorbed by riboflavin, visible energy of all these wavelength destroys riboflavin. It is true that radiant energy must be absorbed if it is to produce an effect whether this effect is detrimental or beneficial—undesirable or desirable. However, the converse is not true. In other words, energy which is absorbed does not necessarily cause any other effect than to heat the material.

A red fabric may fade upon exposure to an illuminant. Its absorption spectrum obviously extends from the middle of the visible spectrum through the green, blue and violet and into the ultraviolet regions. It is not necessarily true that energy of all the wavelengths throughout this absorption spectrum causes the fading. In a given case only the ultraviolet may be primarily responsible for the fading. The absorbed energy of other wavelengths may produce no photochemical effect. It may only raise the temperature of the red fabric.

In the case of a deleterious effect, the absorption spectrum, in a sense, only indicates the woods in which the culprit is concealed; it does not necessarily indicate the tree behind which the culprit is to be found. The absorption spectrum of riboflavin does not prove that energy of any wavelength which is not entirely transmitted causes such a photobiological effect as the destruction of riboflavin.

Initially Dr. Harmon seems to have been insufficiently concerned with glare in his observations and erroneously influenced by the absorption curve of riboflavin. The latter influenced his speculations to the extent that he actually viewed tungsten-filament light favorably owing to its relative paucity in the short-wave region of the visible spectrum. Owing to a greater abundance of short-wave visible energy in fluores-

cent light, he speculated that this illuminant was less satisfactory than tungsten-filament light. No proof of this is available in practice and none is really indicated in theory. In addition, it is well to repeat that millions of persons have been working for long periods under fluorescent light just as many millions have worked and still work under tungsten light. If there is a significant difference in their photobiological effects it seems reasonable to believe that it could not escape discovery by or through this mass experience.

There is still another important aspect to Dr. Harmon's speculation. Let us consider skylight from a clear blue sky. In Fig. 1 it is seen to contain a greater abundance of short-wave visible energy than light from daylight fluorescent lamps for equal intensities of illumination. Countless millions of persons for centuries have performed critical seeing for long periods in the light from the sky. In fact, until relatively recently skylight through windows and other openings has been the universal indoor illuminant. Even today millions read and perform other critical tasks of seeing near windows for long periods daily. If light from the fluorescent lamps in common use is detrimental in any way owing to the abundance of short-wave visible energy—blue and violet—blue sky should be even more detrimental. When one takes into account the levels of illumination such a speculation becomes still more attenuated. Actually there is no evidence upon which to throw aside the great principles of evolution and adaptation. If human eyes are not adapted to natural skylight are they adapted to anything? Thus it is quite a responsibility to indict the spectral characteristics of fluorescent lamps in common use. Actually natural sunlight and skylight will have to stand trial too.

The foregoing are only brief glimpses of major suspicions of fluorescent light. It is gratifying to note the increasing interest of school authorities, health departments, welfare organizations, eyesight specialists and the medical profession. All these will find that there is much available knowledge of the penalties of inadequate light and improper lighting and of the rewards of adequate light and proper lighting. In fact, knowledge of seeing conditions is far ahead of its use in general. We need the cooperation of all these groups and everyone else interested in the conservation of human resources through better seeing. If everyone concerned will view the available knowledge without prejudice and for the benefit of humanity, they will find the present day light sources and knowledge adequate to make much real progress beyond the present generally primitive lighting and seeing conditions. There is much to be done. Speculation and theory may well be left to those working in scientific realms.

THE USE OF VOLUME TWO OF THE DVORINE COLOR PERCEPTION TESTING AND TRAINING CHARTS FOR GRADING COLOR PERCEPTION DIFFICULTIES*

Israel Dvorine, O.D., F.A.A.O.
Baltimore, Md.

The second volume of the Dvorine Color Charts was designed primarily for training purposes, but it can also be used for testing color perception and color discrimination and the results obtained with it offer the examiner a means of grading the extent of the color vision defect.

Volume one of this set consists of 60 charts, the first four of which are to acquaint the patient with the type of response desired from him and to observe, in the shortest possible time, if his color discrimination is faulty. If the patient fails to respond correctly to charts A2, A3 and A4 he is then examined with the rest of the 56 charts of volume one to disclose the specific color combinations which he confuses. All of the 56 charts are printed in two colors and these colors are used in two tints in each chart.

Ten of the seventy charts of volume two of this set are similarly arranged in two-color combinations and each color is used in two tints. All other charts of this volume, numbering 60 charts, are printed in two colors but of one tint each. Twenty of these charts are specifically for training purposes only but the remaining 40 charts in volume two can be used for testing. These charts are simpler in design and more easily distinguished than the 56 charts of volume one.

A patient who fails to see the digits of volume one but can recognize the digits of the same color combinations of volume two, has a relatively lesser degree of color confusion than the patient who cannot see the digits in volume one *and* in volume two. The color combinations common to both volumes are: red and green, red and brown, red and gray, orange and green, and blue and violet.

Thus, it is of interest to test a patient with the charts of volume one and with charts of volume two, if he shows a lack of ability to discriminate between colors, in order to grade the extent of his color difficulty.

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*Submitted on September 1, 1945, for publication in the October, 1945, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

For testing purposes, the following charts of volume two are to be used:

Red and Green

B3, B4, B5, B6, B9, B10, B11, B12

Red and Brown

B17, B18, B19, B20, B23, B24, B25, B26

Red and Gray

B31, B32, B33, B34, B37, B38, B39, B40

Green and Orange

B45, B46, B47, B48, B51, B52, B53, B54

Blue and Violet

B59, B60, B61, B62, B65, B66, B67, B68

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BALTIMORE, MD.

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The American Academy of Optometry and the publishers of this journal have no objection to the reprinting by other magazines of any of the articles in this issue, provided such reprints are properly credited to the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

PROBLEMS OF THE RETURNING OPTOMETRIST

The war which swept thousands of optometrists into the far places of the earth is now over and the non-spectacular postwar period has begun to return some of them to our homeland. Is our profession ready for them? Are they ready to adjust to those conditions which await them at home? Both groups of optometrists have changed by their wartime experiences. These questions are in the minds of many optometrists. They cannot be answered without giving consideration to some of the social forces which will condition the future practice of optometry.

For example, the war has caused two great groups of Americans to have an increased appreciation of proper health care. These groups are first, the millions of men and women in our armed services, and second, that great group of war workers who served in industry under carefully supervised health programs. Both groups have had a higher measure of health care than ever before and in a large part neither group will be willing to forego similar good health care in the future.

As this care was essentially professional in character it is logical that these groups will continue to seek professional health care in the future and this will apply equally to optometrists as well as physicians and dentists.

As optometrists we must realize, too, that the postwar plans of both government and voluntary public health agencies are based on the assumption that these politically powerful groups will demand that professional health care be much more widely distributed than ever before.

Optometry is therefore confronted with a condition that demands strong and courageous leadership. It must adopt the preparation and distribution of returning optometrists to these changing demands. It must provide leadership in supplying refresher courses and economic programs to enable the returning optometrist to re-enter his chosen career on a professional basis. It must supply leadership and programs to enable all optometrists to demonstrate greater competence in the care of visual problems, for the demonstrable skills of good refracting are the cornerstones without which truly professional optometry cannot be universally achieved.

In the amended Wagner-Murray-Dingle Bill, optometry has been recognized as one of the fundamentals of good public health service, and this is just a forerunner of similar measures with which we as a profession will have to deal.

As optometrists generally know, the American Optometric Association has been working on these problems since 1943. Much preliminary work has been done and the time is now ripe to place the entire program in full swing. The Academy stands ready to assist if called upon to do so. Through its Speakers Bureau, competent authorities on every subject germane to optometry may be secured and programs for refresher courses may also be augmented from this same source. The Academy, too, may possibly assist the returning optometrist by having its Fellows personally advise returning optometrists as to the exact plans to follow in opening their offices. All members of the Academy practice professionally and are prepared to mull-over and discuss the newcomer's

contemplated program and advise him from their already extensive background of prior experience in this field.

Most optometrists, after short refresher courses, will return to their practices, which are the very foundation upon which optometry is built. Our good reputation and the esteem in which we are regarded by the public is because of these individual practitioners. For the optometrist returning from service, these individual practices should be encouraged in every possible way by organized optometry.

There is urgent need, too, for some of our returning service men to specialize. Some will want to spend several years in graduate work, ultimately receiving degrees which fit them for teaching in our schools and colleges. Others will wish to take formalized courses to prepare themselves for specialized work with contact lenses, the correction of aniseikonia or the treatment of strabismus. The public demand for optometrists with these special qualifications is enormous and will grow in the years to come. Our educational institutions have an obligation to arrange programs to fill these needs.

However, what of the military optometrists who have no particular plans and are uncertain of the future? These men constitute a challenge to optometry. They have been separated from practice for some time and may fear the future. This group lack motivation or information as to the true opportunities in professional optometry. These are the men most in need of assistance and helpful guidance at this most critical period in their careers. A new start must be made. Will it be towards professional practice and a life-long position of standing and affluence in their local communities, or will it be towards commercialism with its never-ending apologies and its hang-dog attitude and its prostitution of every sound professional ideal? CAREL C. KOCH.

PROCEDURE AND INSTRUMENTATION

Rudolph H. Ehrenberg

A department wherein discussions will be carried on relative to the value of various experimental and clinical techniques as employed by practicing optometrists, and also in which the instruments used by optometrists in various phases of their work, will be subjected to some critical evaluation.

THREE DIMENSION TACHISTOSCOPE

The value of tachistoscopic training has been established. The work of Renshaw especially that in the Navy recognition training program

has shown some of the possibilities. Enough has been learned to help train persons to see better; to form more accurate and complete visual precepts more quickly and firmly.

Renshaw states, "Tachistoscopic training is indicated where you wish to reorganize the visual field pattern at far-point or near-point. With it you can greatly enlarge form fields. You can increase grouping skill to promote greater coherence and unity in the visual perception of forms. The speed and comprehension indices for silent reading will show significant improvement. Obviously, the building of the skill in perceiving visual forms takes a certain minimum amount of time and practice.

The accepted procedure is to expose on a screen for a brief interval digits or other forms at either near or far point, gradually increasing the number of digits and lessening the time of exposure.

For the purpose of digit training with the Tachistoscope there are one hundred slides chosen from those developed at Ohio State and used in Navy recognition training program.

The unit is a 2"x2" glass slide projective with a horizontal slide changer, and uses a 300 watt lamp on a pre-focus base. The lens has a 4-inch focus to provide a large picture at limited distances. The shutter attached to the lens barrel is a number 3 Wallensak Alphax with speeds to 1/100 of a second.

An arrangement on the end of the shutter will hold a polaroid control filter. Polaroid glasses are included for viewing Vectographs. The entire unit including the slides is arranged in a carrying case.

Digit training forms the core or nucleus of routine tachistoscopic training; other accessory training materials are used concurrently for different purposes, for which another hundred slides are included. Thirty of these are simple forms suggested by Robinson, and 15 are digit and simple word slides for fixation training. There are three modified Snellen slides. The balance are Vectorecognition slides. It has been stated that the Vectograph "takes the shackles off" the stereoscope. This appears quite true considering the flexibility of viewing distances. Twenty of these slides are confined to digits and letters, part of the remaining slides to stereometric testing and training, and others to duction training. There are two slides for observing retinal rivalry. Renshaw has this to say on rivalry, "Since the rivalry function can be changed by training, the question arises as to whether this does not or should not have a place in orthoptic procedures." Just where and how presents a problem for

optometrists to decide. Systematic observation of this function in a number of types of eye cases would yield interesting and important findings.

Included is a good test for malingering.

It appears to the writer that the optometrist engaged in visual training and not using tachistoscopic training specifically or supplementary to other procedures should investigate it.

Literature is available at the Three Dimension Company, 500 N. Dearborn St., Chicago, or through Riggs Optical Company.

VISUAL HOME TRAINING

It is pretty much accepted that home training procedures are an effective supplement to office work in visual training. Along this line the Keystone View Company has recently prepared an interesting circular entitled "Keystone Prescriptions."

It is natural that the pamphlet emphasizes accessories available through Keystone; however, there is much more to it than just being an advertising piece. Included is a discussion of the home training in visual skills. The points considered are: Is it effective? Is it practical? Who needs vision training? How should the units be prescribed?

Twenty-one questions and answers are included. These include many of the frequently asked questions with brief but explicit answers.

The balance of the ciruclar is devoted to a complete description of a photograph of the stereograms that make up the new Zeta, Eta, and Pointer-Method Home-Training Services as well as information regarding the types of cases for which these units have been successfully prescribed.

The Correct Eyescope Service is fully illustrated and described, and information on the Alpha, Beta, Delta, Epsilon, and Gamma Units is provided.

The home training service is well organized as indicated in the circular, and worthy of inquiry on the part of optometrists doing visual training.

VISUAL ACUITY

Bausch & Lomb announce a checkerboard diamond shaped pattern to measure visual acuity in conjunction with the ortho-rater. This new test is suitable for patients who are unable to read.

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

NEW MEMBERS OF THE ACADEMY

The following optometrists and educators have been elected to Fellowship in the American Academy of Optometry during the quarter ending September 30, 1945. The Executive Council welcomes these new members.

Dr. Walter I. Auber, 8 Hillcrest Road, Springfield, Vermont.
Dr. Clarence M. Baker, 1½ Center Street, Brandon, Vermont.
Dr. James O. Baxter, Jr. 508 Front St. Beaufort, North Carolina.
Dr. Robert T. Best, Strand Theatre Bldg., Fairmont, Minnesota.
Dr. Henry H. Bisbee, 9 West Union St. Burlington, New Jersey.
Mr. Charles C. Bradley, 96 Main St. Batavia, New York.
Dr. George L. Brown, Paulsboro, New Jersey.
Dr. John J. Brown, 102 Smith St., Perth Amboy, New Jersey.
Dr. Milton A. Bursack, 502 Black Bldg., Fargo, North Dakota.
Dr. Leland G. Chase, 10 Summer St. Springfield, Vermont.
Dr. E. J. Cummins, 411 Main St., Red Wing, Minnesota.
Dr. Austin G. Engel, Little Falls, Minnesota.
Dr. George J. Erskine, 523½ No. Broadway, Pittsburgh, Kansas.
Dr. Alan E. Evans, 352 Elm St. Burlington, Vermont.
Lt. Theo. H. Feinman, H (s) USNR, U.S.N.A.B. Annex 2, Little Creek, Virginia.
Dr. Douglas F. Green, 187 Bank St., Burlington, Vermont.
Lt. Henry A. Imus, H (s) USNR, Department of Ophthalmology, School of Aviation Medicine, U.S.N.A.S. Pensacola, Florida.
Dr. Denny W. Jones, 415 East Broad St., Chester, Pennsylvania.
Dr. Ralph Kullander, 1910 E. 13th St., Des Moines, Iowa.
Dr. Milton H. Lebson, 151 Engle St., Englewood, New Jersey.
Dr. J. J. Livingston, 511 Main St. Little Rock, Arkansas.
Dr. Einar Markhus, 333 East Hennepin Ave., Minneapolis, Minnesota.
Dr. Meredith W. Morgan, 302 LeConte Hall, University of California, Berkeley, California.
Dr. Clifford E. Myers, 310 Rock Island Bank & Trust Bldg., Rock Island, Illinois.
Dr. G. F. Preston, 6 No. Winooski Ave. Burlington, Vermont.

Dr. Martin R. Snook, 7 Main St., Newton, New Jersey.
Dr. S. Benjamin Sobel, 716 Main Ave., Clifton, New Jeersy.
Dr. Edward Steinberg, Research Institute Bldg., 292 Madison Ave., New York, New York.
Dr. M. Steinfeld, 609 Broadway, Paducah, Kentucky.
Dr. Kenneth Berkeley Stoddard, 302 LeConte Hall, University of California, Berkeley, California.
Dr. John W. Wirth, 1212 E. Grand St., Elizabeth, New Jersey.
Dr. Frederick L. Wyman, 304 Service Bldg., Rutland, Vermont.

NOTES ON COMING MEETING OF THE ACADEMY

The annual meeting of the American Academy of Optometry will be held at Columbus, Ohio on December 9, 10, 11 and 12. The sessions will include three special seminars. These are (1) a group meeting dealing with contact lenses which will be presided over by Dr. Eugene Freeman of Chicago, Illinois, (2) a group meeting dealing with orthoptics which will be presided over by Dr. Marguerite T. Eberl of Milwaukee, Wisconsin, and (3) a group meeting dealing with education which will be presided over by Dr. Clarence W. Morris of Fort Wayne, Indiana.

According to Dr. Marguerite T. Eberl, the Monday morning sessions of the Academy meeting will be given over entirely to Visual Training with special emphasis upon the problem of myopia and the functional disabilities of school children. During the first period the paper presented will give a general view of the subject. This will cover the basis, and the purposes of training, and the general outline of procedures. During the last period, demonstrations of the various procedures and techniques will be presented to smaller groups.

Members of the Academy willing to contribute papers to these special group sessions are asked to communicate with the section chairman. However since all fields are so broad the Program Committee reserves the right to limit acceptances to those presentations which are particularly applicable to the several seminars.

In addition to these special group meetings a large portion of the program will be devoted as usual to the presentation of original papers. Among the speakers whose papers have already been accepted for this meeting are the following Academy members and their subjects:

Dr. Ernest Petry, Rochester, New York, "Some Factual Data on the Distribution of Myopia, Hyperopia and Astigmatism in the Bausch and Lomb Optical Company Plant."

Dr. Lewis H. Kraskin, Washington, District of Columbia, "Emotions and the Eye".

Dr. V. J. Ellerbrock, Dartmouth Eye Institute, Hanover, New Hempshire, "Cyclofusion and Oblique Meridional Aniseikonia."

Dr. S. Herman Shurin, Kansas City, Missouri, "Field Charting."

Dr. Eugene Freeman, Chicago, Illinois, "Some Principles of Nomenclature."

Dr. H. W. Hofstetter, Ohio State University, School of Optometry, Columbus, Ohio, "Accommodative Convergence in Squinters."

Additional speakers will be announced during the next several weeks and the complete program presented in the November issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY. Members of the Academy who are planning to attend this annual meeting of the Academy at Columbus, Ohio should now make their reservations at the Deshler Wallick Hotel, Columbus, Ohio.

MARYLAND CHAPTER

The Maryland Chapter of the American Academy of Optometry met on September 20, 1945 at the Lord Baltimore Hotel in Baltimore, Maryland. The guest speaker was Dr. Jacob Harry Conn whose subject was "Psychosomatic Medicine". Dr. Conn is a practicing psychiatrist and a Diplomate of the American Board of Neurology and Psychiatry.

Dr Israel Dvorine, optometrist of Baltimore is Chairman of the Maryland Chapter and Dr. A. G. Billmeier, optometrist of Denton Maryland is Secretary.

SOUTHERN CALIFORNIA CHAPTER

The Southern California Chapter of the American Academy of Optometry held its September meeting at the Los Angeles Athletic Club on Friday September 14.

Dr. Peter Spencer, Professor of Education at Claremont College was the speaker of the evening. His subject was, "Vision Training and the Educational Process".

Dr. E. A. Hutchinson, President of the Southern California Chapter appointed the following members to serve as a Nominating Committee, Dr. Harry E. Goodman, Dr. E. C. Deacon and Dr. Glenn Winslow.

Dr. E. A. Hutchinson, also appointed the following members of the Southern California Chapter to serve as a Chapter Examining Board for the American Academy of Optometry in Southern California: Dr. Harry E. Goodman, Chairman, Dr. William M. Ketchum, Secretary, Dr. Harry L. Fuog, Dr. Arthur E. Hoare, Dr. Leslie W. Scown and Dr. Elisabeth S. Wright.

BOOK NOTICES AND REVIEWS

Books received are acknowledged by notices in this department. Special selections will be made for more extensive review in the interest of our readers as space permits.

REFRACTION OF THE EYE. Alfred Cowan, M.D. Published by Lea & Febiger, Inc. Second Edition, Octavo, 278 pages, illustrated with 181 engravings and 3-color plates. Cloth, $4.75.

This book evolves from Cowan's teaching of Refraction at the University of Pennsylvania. Thus quite properly the early chapters are devoted to theoretical optics. Presented very well are those experiments and formula that have to do with refraction.

From this beginning the clinical aspects emerge in quite logical and orderly sequence. There is a certain amount of repetition and this might be properly expected from one thinking as a teacher.

The clinical concepts are ophthalmological. Despite this the thoughtful optometrist will be well rewarded for the time taken in reading this book. RUDOLPH EHRENBERG.

SPECIAL REPORTS

A STATISTICAL REVIEW OF THE OCULAR PROBLEMS OF YOUNG MEN*

The physical examination of selectees to determine acceptability for induction into the armed forces affords a unique opportunity for estimating the incidence of various ophthalmic conditions in a comparatively large and statistically significant group of men. This study

*An abridgment of the material "Ocular Defects in Sixty Thousand Selectees", Dr. A. H. Downing, Archives of Ophthalmology, reprinted form Continental Digest, March-April 1945.

consists of an analysis of the results of the examination of 60,000 men, a consecutive series, at an armed forces induction station.

The men examined represented an age group of from 18 to 38 years, together with a few enlistees age 17 and selectees between 38 and 45 years of age. Thus ophthalmic conditions peculiar to childhood, puberty, and senescence were not encountered. In addition, preliminary "screening" examinations, performed by physicians at the various local selective boards, eliminated from the group some who were obviously visually unfit.

Of the 60,000 men in this series, 5,712 (9.5 per cent) were found to have ophthalmic defects. Data were accumulated in the course of the complete physical examination for induction, and not from a mere analysis of records.

The examination of each man was made methodically and according to a definite plan. The visual acuity of each eye was tested separately, with and without glasses.

When any selectee required more time for ophthalmologic investigation than could be taken at the original examination, he was detained until an adequate study of the ocular abnormality could be made.

Refractive Errors—Selectees with uncorrected visual acuity below 20/200 due to refractive errors totaled 2,032, or 3.4 per cent of the entire series (Table 1). Myopia, with and without associated astigmatism, was the cause in 93 per cent of cases of defective vision due to refractive errors. The low figures for hypermetropic errors are probably due to the relatively high accommodative power present in persons of this age group.

Table 1—Incidence of Refractive Errors in a Series of 60,000 Selectees

	Total No.	Ratio
Myopia, below 20/200 to 20/400	1,525	1:40
Myopia, below 20/400	362	1:166
Myopia, high, unilateral	48	1:1,250
Hypermetropia, below 20/200 to 20/400	71	1:845
Hypermetropia, below 20/400	26	1:2,305
	2,032	1:30

Forty-eight cases of high unilateral myopia were encountered. This comparatively infrequent condition is not strictly refractive but is included in this category. In all 48 cases one eye was essentially normal

whereas the fellow eye was highly myopic, to the extent of 10 D. or more, and usually gave the appearance of unilateral exophthalmos.

Strabismus—Of the total number of men examined, 1,245, or 2 per cent, had manifest strabismus (Table 2). The number of cases of convergent types was 855, and the number of cases of divergent types was 389. Amblyopia ex anopsia was an associated condition in 1,066 of the 1,245 cases. Further, amblyopia ex anopsia was encountered much more frequently in conjunction with convergent strabismus than with divergent strabismus; it was an associated condition in 90 per cent of the cases of esotropia, whereas it was present in only 60 per cent of the cases of exotropia.

Table 2—Number of Selectees with Strabismus in Series of 60,000

	Total No.	Ratio
Esotropia, with amblyopia	770	1:78
Esotropia, without amblyopia	85	1:706
Exotropia, with amblyopia	296	1:202
Exotropia, without amblyopia	93	1:646
Right hypertropia	1	
	1,245	1:48

In this series, two factors bear on the incidence of strabismus. First, only cases of manifest strabismus are included. Thus, cases in which treatment had been effective either by prescription of glasses or by operative intervention and cases in which the deviation had disappeared spontaneously as the patient reached adulthood are not classified here. Second, as previously stated, complete examination to determine the exact degree of ocular muscle balance was not done routinely, and thus it is possible that a small number of cases of the alternating type of strabismus with normal central visual acuity in each eye, and with deviation of low degree, were over-looked. However, the presence of poor visual acuity with appropriate correcting lenses (amblyopia) not accounted for by the presence of organic disease always required further investigation, including examination of the muscle balance, and thus associated strabismus of low degree would then be noted when otherwise it might not have been observed.

Paralysis of Extraocular Muscles—Paresis or paralysis of the extraocular muscles was an infrequent finding; 24 cases were noted, a ratio of incidence of 1:2,500.

Optic Nystagmus—There were 80 cases of idiopathic optic nystagmus in this series, a ratio of incidence of 1:750.

Congenital Anomalies—The many and varied types of anomalies encountered are listed in the tables, together with the other defects of the structures of the eye concerned.

External Ocular Abnormalities—Disorders of the adnexa and the external parts of the eye were seen in 295 cases, a ratio of incidence of 1:203 (Table 3).

Table 3—Number of Selectees with External Ocular Abnormalities in a Series of 60,000

	Total No.	Ratio
Corneal scars, acuity below 20/40	93	1:645
Blepharoptosis	46	1:1,300
Active trachoma	25	1:2,400
Pterygium	23	1:2,610
Interstitial keratitis	14	1:4,280
Microphthalmos, unilateral	12	1:5,000
Dermoid	10	1:6,000
Keratitis, miscellaneous types	10	1:6,000
Albinism	8	1:7,500
Conjunctivitis, chronic, severe	8	1:7,500
Blepharitis marginalis	7	1:8,570
Keratoconus	5	1:12,000
Dacrocystitis, chronic	4	1:15,000
Epicanthus, marked	3	1:20,000
Exophthalmos, thyrotoxic	3	1:20,000
Conjunctivitis, acute, severe	3	1:20,000
Lacrimal fistula	2	1:30,000
Loss of one eye, ophthalmia neonatorum	2	1:30,000
Tarsectomy, post-trachoma	2	1:30,000
Microphthalmos, bilateral	2	1:30,000
Other conditions*	13	
	295	1:203

*One case each of conjunctival hemangioma, blepharochalasis, congenital corneal opacity with ambryotoxon, vernal conjunctivitis, senile extropion, episcleritis, juvenile glaucoma, hypertelorism, lye burns of the orbit, benign melanoma of the caruncle ocular pemphigus, blepharotoptosis with hemangioma and severe post-traumatic orbital scarring with exotropia.

Iris—In 41 cases, a ratio of 1:1,460, lesions of the iris occurred as the ocular defect of primary importance. The lesions of the iris usually present in eyes undergoing involuntary changes due to destructive injury or disease were not included.

Lens—Abnormalities of the crystalline lens of the eye were encountered in 257 cases (Table 4). Cases of traumatic and secondary cataract, such as is usually found in eyes subject to involuntary changes following extensive injury or disease, were not included in this total.

Table 4—Incidence of Abnormalities of Lens in a Series of 60,000 Selectees

	Total No.	Ratio
Cataract, traumatic	107	1:560
Cataract, congenital	45	1:1,330
Cataract, secondary	18	1:3,330
Aphakia, operative, monocular	35	1:1,700
Aphakia, post-traumatic	14	1:4,280
Aphakia, operative, bilateral	9	1:6,660
Traumatic dislocation of lens	12	1:5,000
Ectopia lentis	9	1:6,660
Coloboma of lens and iris	2	1:30,000
Other conditions*	6	
	257	1:233

*One case each of cataract due to lightning, sunflower cataract in a case of chalcosis, partial cataract with post-traumatic coloboma of the lens and iris, operative aphakia with myopic chorioretinitis, traumatic central chorioretinitis and bilateral microphthalmos.

Vitreous—Abnormal conditions of the vitreous body were noted in 17 cases, a ratio of 1:3,550.

Optic Nerve—The optic nerve showed abnormalities in 53 cases, ratio of 1:1,132. In 45 of these cases there were optic nerve atrophy of some form. In 25 cases a definite history of blindness in one eye following trauma, usually basal fracture of the skull, was obtained, and for this reason the blindness in these cases is called post-traumatic; in 15 cases no definite etiologic factor could be determined. Three cases of hereditary optic atrophy were encountered.

Retina and Choroid—Abnormalities of the retina and choroid formed a large and varied series, difficult to classify satisfactorily. The

374 cases have been grouped into five categories: anomalies, 160 cases; generalized diseases of the retina and choroid, 60 cases; abnormalities of the central region, 97 cases; retinal detachment and closely allied conditions, 38 cases, and typical myopic chorioretinitis, 19 cases (Table 5).

Monocular Loss of Vision—A total of 2,932 cases of monocular loss of vision due to amblyopia (defined previously as corrected vision below 20/40), trauma or disease were seen in this series (4.9 per cent). In 836 of this number the loss was the direct result of trauma, whereas in 2,096 cases it was of non-traumatic origin (Tables 6 and 7).

Table 5—Incidence of Abnormalities of the Retina and Choroid in a Series of 60,000 Selectees

Anomalies	Total No.	Ratio
Medullated nerve fibers	140	1:428
Coloboma of choroid	12	1:5,000
Colloid bodies	2	1:30,000
Melanoma of fundus, benign	2	1:30,000
Tuberous sclerosis	2	1:30,000
Other conditions*	2	
	160	1:375
Generalized disease		
Choroiditis, cause undetermined	20	1:3,000
Retinitis pigmentosa	14	1:4,280
Chorioretinitis disseminata	7	1:8,570
Choroidal sclerosis	4	1:15,000
Healed choroidal rupture	4	1:15,000
Post-traumatic retinopathy	4	1:15,000
Coats's disease	2	1:30,000
Other conditions†	5	
	60	1:10,000
Central		
Central chorioretinitis, post-traumatic, healed	50	1:1,200
Central chorioretinitis, healed	24	1:2,500
Batten-Mayou disease	11	1:5,460
Solar retinopathy	11	1:5,460
Other conditions‡	1	
	97	1:620

Retinal detachment		
Post-traumatic	18	1:3,330
Complicated	7	1:8,580
Successful operative repair	6	1:10,000
"Idiopathic"	5	1:12,000
Other types§	2	
	38	1:1,580
Myopia		
Unilateral with myopic chorioretinitis	9	1:6,660
Chorioretinitis, with high myopia	8	1:7,500
Other types°	2	
	19	1:3,150
	374	1:160

*One case each of choroideremia and von Hippel-Lindau disease.

†One case each of chorioretinal atrophy with glaucoma circinate retinopathy, Eales's disease, chorioretinitis due to metallic copper, and "salt and pepper" fundus.

‡One case of presenile bilateral macular degeneration.

§One case of congenital nonattachment of the retina with microphthalmos and unsuccessful operative repair of retinal detachment.

°One case each of bilateral myopic chorioretinitis and aphakia and unilateral myopic chorioretinitis with unilateral myopia of only 3 D.

Table 6—Incidence of Nontraumatic Monocular Loss of Vision in a Series of 60,000 Selectees

	Total No.	Ratio
Amblyopia without strabismus	855	1:70
Amblyopia with esotropia	770	1:78
Amblyopia with exotropia	295	1:203
Myopia, unilateral, high	48	1:1,250
Congenital cataract	44	1:1,360
Central chorioretinitis	24	1:2,500
Optic nerve atrophy, nontraumatic	20	1:3,000
Cataract, secondary	18	1:3,330
Glaucoma, primary and secondary	9	1:6,660
Retinal detachment, "idiopathic"	6	1:10,000
Coats's disease, active	2	1:30,000
Loss of one eye from ophthalmia neonatorum	2	1:30,000
Other conditions*	3	
	2,096	1:29

*One case each of active Eales's disease, van Hippel-Lindau disease and recurrent hemorrhages in the vitreous.

Table 7—Incidence of Post-Traumatic Monocular Loss of Vision in a Series of 60,000 Selectees

	Total No.	Ratio
Traumatic loss of one eye	469	1:128
Traumatic cataract	109	1:550
Corneal scar, visual acuity below 20/40	71	1:845
Post-traumatic central chorioretinitis	50	1:1,200
Aphakia, operative and post-traumatic	49	1:1,224
Optic nerve atrophy, post-traumatic	25	1:2,400
Retinal detachment, post-traumatic	19	1:3,160
Post-traumatic dislocation of lens	12	1:5,000
Solar retinopathy	11	1:5,450
Retinitis proliferans, traumatic	6	1:10,000
Healed choroidal rupture	4	1:15,000
Post-traumatic retinopathy	4	1:15,000
Post-traumatic hemorrhage in vitreous	4	1:15,000
Other conditions*	3	
	836	1:72

*One case each of chorioretinitis due to metallic copper, loss of one eye following operative correction of strabismus and amblyopia ex anopsia with exotropia following extensive orbital scarring in infancy.

The 469 instances of "post-traumatic loss of one eye" represented a multiplicity of pathologic lesions. This term was used to include phthisis bulbi, any other involuntary process, extensive corneal leukoma and post-traumatic removal of one eye.

Post-Traumatic Conditions Without Visual Loss—Sequelae of trauma were noted in 38 cases in which the corrected visual acuity remained 20/40 or better.

COMMENT

Analysis of the results of the examinations in these cases reveals one finding of great practical importance from both the future military and the economic standpoint and affords evidence of the need for more effective preventive ophthalmologic practices. A total of 2,932 cases of monocular blindness or partial loss of visual acuity were found; this represents 4.9 per cent of the men in the entire series, or 1 out of each 20 examined. Further, this one condition, loss of vision of one eye, was by far the most common of any found in this series of 60,000 cases,

since of the 5,712 cases of ocular abnormalities of all varieties, the 2,932 instances of monocular visual loss comprised more than half, or 51 per cent.

Extension of these figures to the number of men of military age of this nation indicates that of each million men, 49,000 are handicapped by poor vision in one eye. These men are less effective not only as members of the armed forces in time of war, but as members of society in time of peace. This situation is the more unfortunate since of these 2,932 cases of monocular visual loss, 94 per cent may be considered as representing preventible types. Cases of post-traumatic monocular blindness, 836 in number, comprised 28 per cent. In all these cases the blindness may be considered as preventible; in many cases it was caused by an industrial or occupational accident, and in others, by injury received in childhood from firecrackers, dynamite caps or other dangerous objects. Amblyopia was the type of poor vision found in 1,920 cases—in 855 cases without strabismus, in 770 cases with convergent strabismus and in 295 cases with divergent strabismus. Experience has shown that the diagnosis of amblyopia can be made in early childhood and, in nearly all cases, can be remedied by proper measures, such as occlusion, refraction, orthoptic training and operative intervention. These 1,920 cases, together with 2 instances of ophthalmia neonatorum, form 66 per cent of all the cases of monocular visual loss. Thus, theoretically, only the remaining 6 per cent, or 174 cases, may be considered as instances of nonpreventible blindness.

Suitable preventive ophthalmologic measures should be taken in order to lower the percentage of men of military age hindicapped by poor vision in one eye. The important factors to be considered in any such program are two: First, measures should be taken in order to reduce the incidence of post-traumatic monocular blindness. The existing educational and preventive program directed toward the prevention of industrial and occupational accidents should be expanded and broadened, and further efforts should be made to eliminate such ocular injuries as occur in childhood. Second, since amblyopia is responsible for 66 per cent of all monocular poor vision, particular efforts should be extended in order to reduce the incidence of this condition. Amblyopia can be remedied only in early childhood; therefore the diagnosis must be established at an early age. This could best be accomplished by routine examination of each preschool child, followed by the indicated treatment. Great difficulties are inherent in any such program. However, the elimination of preventible monocular visual loss should be a goal of all organizations and persons interested in the conservation of vision.

ABSTRACTS

A department in which will appear abstracts of the literature of optometry, ophthalmology and applied optics. These will be classified according to the following list although contributions to all sections will not necessarily appear in each issue.

1. Ocular Refraction.
2. Physiological Optics and Color Vision.
3. Ocular Muscles.
4. Orthoptics and Reading.
5. Anatomy, Histology and Embryology.
6. Ocular and General Pathology.
7. Ophthalmic Lenses and Material.
8. Instruments.
9. Hygiene and Illumination.
10. Applied and Physical Optics.
11. Education, Sociology and Economics
12. Miscellaneous.

12. MISCELLANEOUS

SOCIAL HEALTH CARE IN GENERAL AND IN PARTICULAR.

Ernest A. Hutchinson. Optical World. 1945, 33, 2, 30-32.

Hutchinson believes that a program of rather widespread public health care is sure to come, and he answers the question as to optometry's place in such program as follows: "Obviously any large scale health activities will impose the necessity of administering them from centers where diagnosticians and many types of specialists will cooperate. Probably also many persons particularly in the smaller communities will be referred to cooperating practitioners for diagnosis and treatment in their offices. The probabilities are that refraction will be provided for by the regular contributions and that glasses and frames of certain standard types also may be included for those whose prescriptions are above a certain minimum power established by those whose function it is to make the rules. The American public is not likely to take too kindly to standardized materials in anything so conspicuous as spectacle ware, hence doubtless there will be a continuing and probably increasing demand for attractive eye ware for which the public will be willing, even anxious, to pay a premium. As we view it it is important that optometrists are included in the panels of those certified to do the examining which will provide an occupation and excellent training for younger men and women recently graduated and on a 'salary' or 'capitance' or 'fee for service' basis which shall stimulate them to do their best work, give them a place of honor and respect in the community while affording them the opportunity for self improvement through periodical leave for graduate study. Socialized financing of health care means 'more' health care. It is the duty and high privilege of the professions to see to it that it is 'better' care, not merely better but the 'best' that science and skill can achieve." T.O.B.

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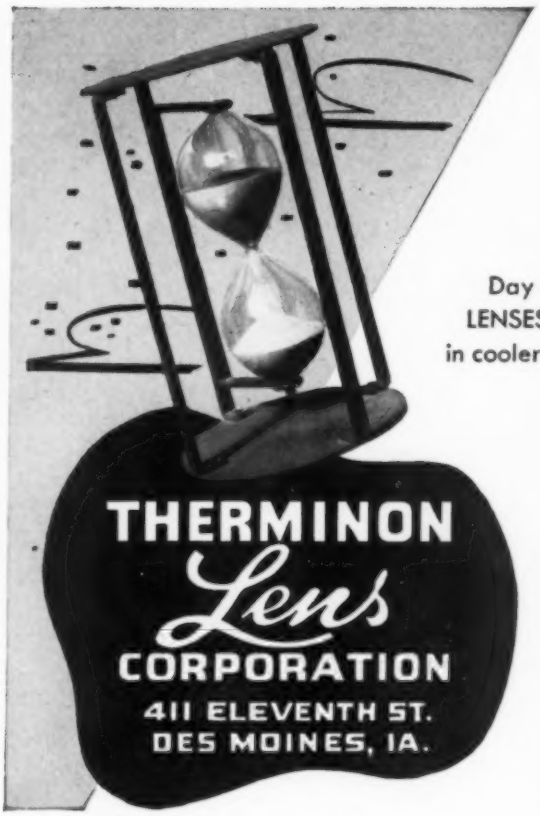

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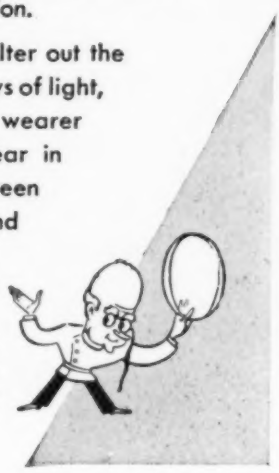

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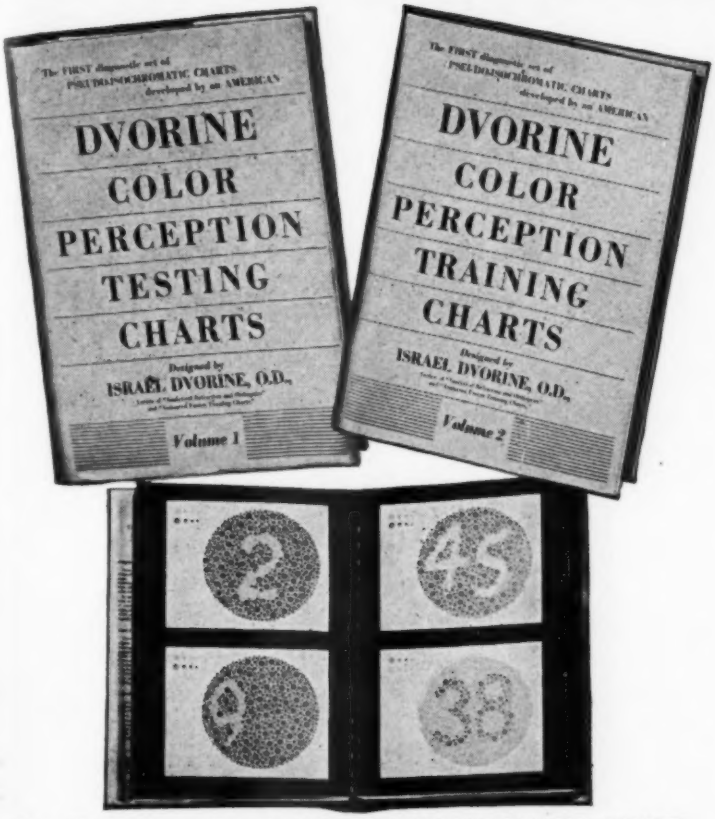

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